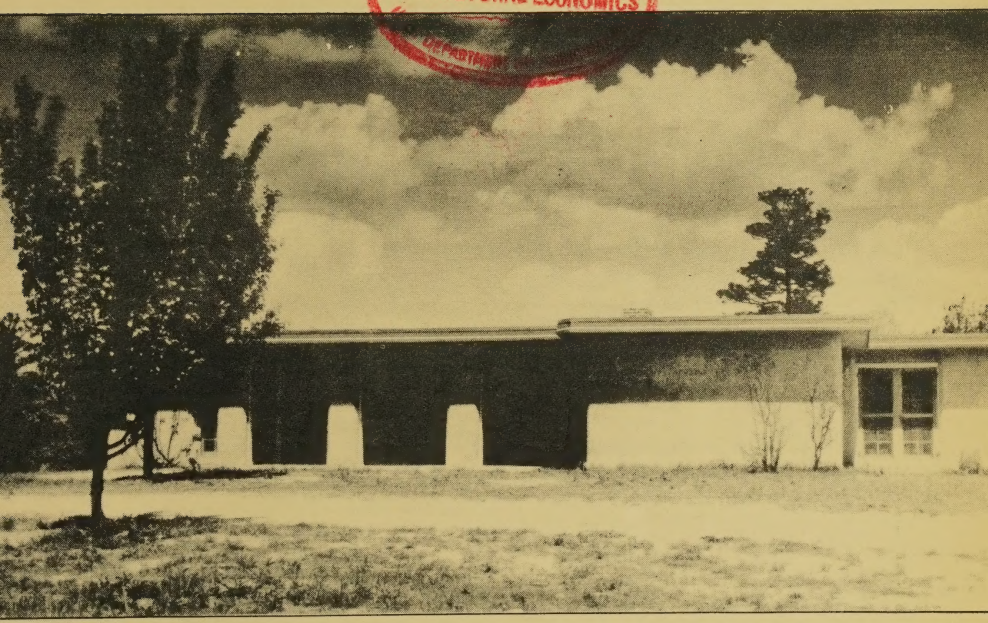
HOUSES OF RAMMED EARTH CONSTRUCTION



UNITED STATES DEPARTMENT OF AGRICULTURE
RESETTLEMENT ADMINISTRATION
WASHINGTON D.C.

Seven houses, each having a separate barn and pump house, have been built of rammed earth at Gardendale, Alabama, as an experiment in and demonstration of the use of earth as a structural material.

These homes form a part of the Resettlement Administration's project at Gardendale, about 13 miles north of Birmingham, Alabama. This community provides homes and gardens for a group of low-income families who work in and around Birmingham.

The rammed earth houses constructed here have from five to six large rooms. Each house contains a kitchen, a combination living and dining room, hallway, and two or three bed rooms. They are simple in design, with flat roofs, and are one story in height.

Earth, in various forms, has been used for building construction since prehistoric times under widely varying climatic conditions and in almost all parts of the world.

The most ancient methods were probably sods, sun dried brick, and clay covered wattle. The compacting of walls in place through the use of movable forms was probably perfected by the Carthaginians from whom the Romans learned the art which they, in turn, introduced to all parts of Western Europe.

The method has been in use in modern times, particularly in France, Germany, England and Sweden. A number of buildings constructed of rammed earth, prior to the American Revolution, still stand in good condition both in Europe and in this country.

Considerable experimental work in the field of rammed earth construction has been done in recent years, particularly by E. W. Coffin and H. B. Humphrey of the Department of Agriculture; R. L. Patty and L. W. Minium of the State College Experiment Station, Brookings, S. D.; Clough Williams-Ellis of England and Karl J. Ellington of Port Angeles, Washington.

In designing and building the experimental houses at Gardendale, Thomas Hibben, Consulting Engineer of the Resettlement Administration, used an adaptation of the wall form method. The material used was a combination of sand, clay

and coarse aggregate such as is usually found available in natural earth below the top soil in almost all parts of the United States.

The composition of the material suggested as a result of the experimentation carried on at Gardendale, is three parts sand, two parts clay, one part coarse aggregate. This may be varied to suit local conditions but in no case should there be more than 30 percent clay nor less than 16 percent coarse aggregate. The amount of water present should be from 10 percent to 12 percent. The coarse aggregate may be broken stone, slag or gravel. A careful analysis to determine the exact composition of the soil and the percentage of water is advisable.

When the earth is mixed it is put into forms in layers of about 4" in depth. It is then compacted into a hard mass by tamping. The workmen stand inside the forms and knead the earth with a rhythmic stroke. This stroke is an important feature. The action of tamping is one of kneading rather than pounding, and does not require force. Once it is learned, the men can work steadily for a long time without tiring. A good tamper can be made from a 4 x 10 x 15 inch block of hard wood, the 10 inch face beveled on one side so that the tamping edge is approximately 1 1/2" by 10". With a 3/4" iron pipe handle, the tool weighs about 18 pounds.

The forms are made of 2" lumber and consist of side walls and end gates. The side walls are 30" high and are braced vertically with 2 x 4 inch struts at 3'-0" on center. Through these struts at 6" from the top and bottom are threaded 1/2" iron bolts. These bolts serve to hold the forms together while the tamping is done. End gates are made the full height of the wall from footing to plate; they are plumbed and braced and remain in place until the wall section is complete. When a form has been tamped full the side boards are taken off, the belts drifted out and the side walls raised into place for another 30" layer. For all practical purposes all the forms needed are a straight wall section, a right and left hand corner, and a Tee Section.

Walls should be built on concrete footings -- extending at least 6" or preferably 12" above grade. The top of the footing should be damp proofed by membrane waterproofing, such as tar or asphalt. During construction the upper surface of the wall should be protected from standing water.

Although a 12" wall is adequate for a one story building a 15" wall gives a better working space. The average rate of wall production is 2/3 Cubic Yards per man per day including all workmen whether digging earth, tamping or raising forms. Rammed earth has a bearing strength in excess of 30 tons per square foot. It does not have much strength in bending so all walls should be proportioned to their height (about 1 1/2 times the standards for brick construction.)

A wide variety of protective coverings for the walls has been tried but the best appears to be - one coat of linseed oil followed by two coats of oil paint. Satisfactory results have been obtained by painting after the wall has become dry, but a better finish is acquired by painting about five days after the completion of the wall. A mixture of hydrated lime, trisodium phosphate, casein glue, formaldehyde and water gives a lime wash which appears to stand up well under weathering. However, its permanence is not yet fully determined.

Both in England and America satisfactory protective surfaces have been applied by the use of 1-4 cement plaster both with and without metal lath; but the Resettlement Administration's experiments with stucco have not been entirely successful to date.

After a wall has thoroughly dried, it may be plastered on the inside without lath; however, the painted surface is recommended as being considerably cheaper..

Floors may be of any type - cement on concrete slab, tile, asphalt, linoleum or wood.

While flat, dead level roofs were used on the Gardendale houses, any other type is suitable. The eaves, however, should always extend about 16" beyond the face of the wall.

Although even hard driven rains do not injure a protected wall, concentrated and continuous streams of water will damage the surface. For this reason gutters with down spouts are recommended.

In the Gardendale houses the openings were made the full height of the wall and provided with French doors; however, windows may be used if desired - the sills being cast in place.

Plumbing pipes may be tamped in place in the wall or carried under the floors. Electric wiring in conduits may be set in chases cut in the wall and subsequently plastered over.

The advantages of this type of construction are: the cost of such a structure properly designed and built should not be more than 3/4 the cost of a frame house of the same size and equipment; it will at the same time provide a house that is warmer in winter and cooler in summer; a house that is fire proof, and the walls of which are not subject to termite attack. Such a house with inexpensive maintenance should last for several lifetimes.

A typical floor plan for a rammed earth house is the following: Main entrance into a combination living-dining room that is approximately 12 x 22'. At one end of the room is the entranceway to a 11 x 12' kitchen; at the other end is the hallway. Three bedrooms open off three sides of the hall. Their average dimensions are about 12 x 12'. A bathroom, approximately 8 x 6' also opens off the hall. The plan is designed so that any of the bedrooms may be omitted, if desired.

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RECOMMENDED REFERENCES:

Farmers Bulletin No. 1500, "Rammed Earth Walls for Buildings", U. S. Department of Agriculture, Washington, D. C.

Bulletin No. 277, Department of Agricultural Engineering, Agriculture Experiment Station, Brookings, South Dakota.

"Modern Pise Buildings", Karl J. Ellington, Port Angeles, Washington.

"Lower Cost Buildings", E. W. Coffin and H. B. Humphrey, The Publicity Co., New York City.

"Cottage Building in Cob, Pise, Chalk and Clay", Clough William-Ellis, Scribner's, New York City.

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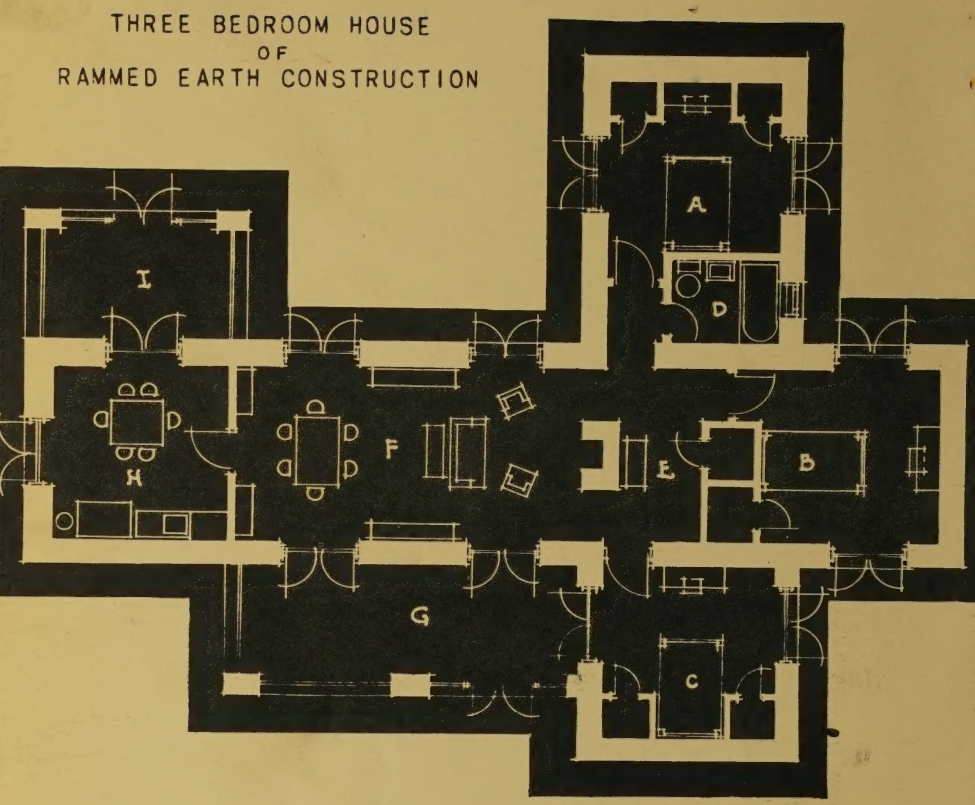
THREE BEDROOM HOUSE
OF
RAMMED EARTH CONSTRUCTION



LEGEND

A	BED ROOM	12 x 12
B	BED ROOM	12 x 12
C	BED ROOM	12 x 12
D	BATH	6 x 8
E	HALLWAY	6 x 12
F	LIVING ROOM	12 x 23
G	FRONT PORCH	9 x 25
H	KITCHEN	12 x 12
I	REAR PORCH	9 x 15

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MATERIALS

REINFORCED CONCRETE FOOTINGS AND FLOOR SLAB...WOOD OR ASPHALT TILE FINISHED INTERIOR FLOORS....RAMMED EARTH BEARING WALLS....STUD PARTITIONS..BUILT UP TAR AND SLAG ROOFING ON DEAD LEVEL WOOD DECK. WOOD FRENCH DOORS..INTERIOR WALLS AND CEILINGS PLASTERED..EXTERIOR WALLS LIME COLOR WASHED....WOOD SOFFIT...ALL PLUMBING WIRING AND FIXTURES INCLUDED IN ESTIMATE.